Probing Single-Molecule Neuron-Ligand Pathfinding

R01 NS40678 and EB00463; a Bioengineering Research Partnership between the University of Delaware and the University of Utah

The Partnership

Tom Beebe (PI)
Surface Analytical Chemist

Professor and Director, Surface Analysis Facility

Ligand-receptor bond-rupture forces, biomaterial surface chemistry, scanning probe microscopy, surface analysis.

Patrick Tresco (PI at Utah)
Neuroscience-Oriented Bioengineer

Associate Professor, and Director, W.M. Keck Center for Tissue Engineering

Cellular-based molecular delivery systems, neurodegenerative, neuroendocrine-deficiency disorders, CNS regeneration.

Vladimir Hlady (co-PI at Utah)
Biophysics-Oriented Bioengineer

Professor and Chair, Department of Bioengineering; co-Director, Center for Biopolymers at Interfaces

Interfacial biophysics, protein adsorption, induced molecular recognition, polymer surfaces

Introduction & Motivation

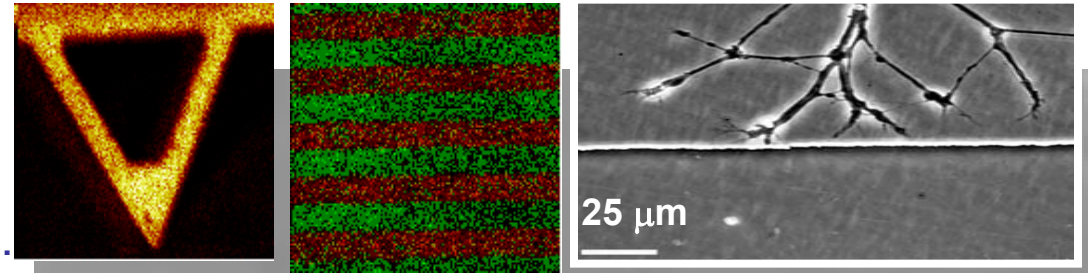
* A damaged central nervous system has only a limited ability for repair and regeneration due to factors that are not yet well understood.

* "Biomaterial bridges" can in principle be used to reconstruct neuronal growth pathways.

* How do biomaterial bridges affect neuronal growth on well characterized materials and surfaces ?

Rat DRG Neurites on Fibronectin-Covered Surfaces

- We functionalize AFM tips with ligands to directly probe neurons.
- We pattern and functionalize materials to influence neuron growth.
- We watch neurons from below while using AFM to probe the forces from above.
- Movie collected over 2.25 hours with 40× objective, playing ~870 times faster than real-time process.



Note formation of new junctions between different neurite branches

~50 μm